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Proceedings Series 2011/034 | **Compte rendu 2011/034**

Maritimes Region | **Région des Maritimes**

Proceedings of the Western Component Pollock (4Xopqrs5) Management Strategy Evaluation Science Peer Review

9-10 May 2011
St. Andrews Biological Station

Meeting Chairpersons:
Julie M. Porter and Stefan Leslie

Compte rendu de l'examen scientifique par les pairs concernant l'évaluation de la stratégie de gestion de la goberge de la composante Ouest (4Xopqrs5)

9-10 mai 2011
Station biologique de St. Andrews

sous la présidence de :
Julie M. Porter et Stefan Leslie

Biological Station / Station de biologie
Fisheries & Oceans Canada / Pêches et Océans Canada
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August 2011 | **Août 2011**

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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August 2011 Août 2011

ISSN 1701-1272 (Printed / Imprimé)
ISSN 1701-1280 (Online / En ligne)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
200, rue Kent Street
Ottawa, Ontario
K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/

CSAS-SCCS@DFO-MPO.GC.CA

Correct citation for this publication:
On doit citer cette publication comme suit :

DFO. 2011. Proceedings of the Western Component Pollock (4Xopqrs5) Management Strategy Evaluation Science Peer Review; 9-10 May 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/034.

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SUMMARY

The Western Component (4Xopqrs+5Zc) Pollock Management Strategy Evaluation (MSE) Regional Advisory Process (RAP) was held 9-10 May 2011, at the St. Andrews Biological Station, St. Andrews, New Brunswick. Participants included DFO staff (Science and Fisheries Management branches), Industry, and external experts. The objectives of this RAP meeting were to complete the Western Component Pollock MSE on which recommendations will be based for risk management of Western Component Pollock, and to identify where to focus future research efforts to provide the greatest improvements to management advice. It was concluded that the Management Strategy Evaluation developed for Western Component 4Xopqrs5 Pollock is sufficiently robust to plausible uncertainties, and if the selected Management Procedure (MP) is employed, will result in an acceptable trade-off between the three Management Objectives. The Management Procedure selected should be used to derive management advice and guide management decisions, unless any of the Exceptional Circumstances are deemed to apply. The expected operating timeframe for this MSE is 5 years, after which there will be a thorough review. This may result in a revision to the MP.

There will be a Science Advisory Report and one Research Document resulting from this meeting in addition to the Proceedings.

SOMMAIRE

Dans le cadre du processus consultatif régional (PCR), on a tenu une réunion portant sur l'évaluation de la stratégie de gestion (ESG) de la goberge de la composante Ouest (4Xopqrs + 5Zc) les 9 et 10 mai 2011 à la Station biologique de St. Andrews, au Nouveau-Brunswick. Y participaient des membres du personnel du MPO (Sciences, et Gestion des pêches) ainsi que des représentants de l'industrie et des experts externes. Cette réunion du PCR avait pour but de procéder à l'ESG de la goberge de la composante Ouest, sur laquelle seront fondées des recommandations de gestion du risque concernant la goberge de cette composante, et de déterminer où faire porter les efforts de recherche futurs pour améliorer le plus possible l'avis de gestion. On a conclu que l'évaluation de la stratégie de gestion établie pour la goberge de la composante Ouest (4Xopqrs5) est suffisamment fiable face aux incertitudes plausibles et que si la procédure de gestion (PG) retenue est adoptée elle aboutira à un compromis acceptable entre les trois objectifs de gestion. La procédure de gestion retenue devrait être utilisée pour établir l'avis de gestion et orienter les décisions de gestion, sauf dans les cas où on estime que l'une quelconque des circonstances exceptionnelles évoquées s'applique. La durée d'application prévue de l'ESG est de 5 ans, après quoi un examen approfondi sera entrepris, qui pourrait aboutir à une modification de la PG.

Outre le compte rendu, cette réunion aboutira à la publication d'un Avis scientifique et d'un Document de recherche.

INTRODUCTION

The meeting was co-chaired by Dr. Julie M. Porter (Science) and Mr. Stefan Leslie (Fisheries Management).

The meeting Agenda, Terms of Reference, and List of Participants can be found in Appendices 1-3, respectively. These Proceedings are meant to serve as a consensus summary of the workshop's principle discussions and conclusions and is not intended to be a chronological transcript. The Proceedings complements the Science Advisory Report (SAR) and the Research Document and is not intended to be used in isolation. The SAR captures the discussion and conclusions of the meeting; the Proceedings document expands somewhat on how those conclusions were reached and the major discussion points; the Research Document provides sufficient detail so the exercise could be repeated.

There has been consideration by Fisheries Management (FM) and Industry to manage Western Component Pollock (4Xopqrs+5Zc) using more of a risk management approach. In July 2010, FM discussed a Management Strategy Evaluation (MSE) approach with Science and Industry, where management objectives and harvest control rules are specified up front. In December 2010 the approach began with a workshop to explore the existing assessment model (using VPA) to understand the sources of uncertainty by running sensitivity analyses for a plausible range of variables for the key areas of uncertainty, and evaluating their impact on both utilization and sustainability objectives (Porter and Docherty 2011). Participants included DFO staff (Science and Fisheries Management branches), Industry, and external experts. The objectives of the workshop were to gain a better understanding of the MSE process and to progress towards development of a structure on which recommendations will be based for risk management of 4X5 Pollock. A set of 12 Operating Models (OMs) and a Reference Set (RS) were agreed upon. Industry and Fisheries Management participants agreed to several Management Objectives to be evaluated in the MSE. A 5-month work plan was established. It was agreed that the next step would be a Regional Advisory Process (RAP) meeting.

On 14 February, 5 April and 21 April, 2011, conference calls were held to review interim analyses and to advance progress towards adopting a Management Procedure (MP) for Western Component Pollock. The records of those meetings can be found in Appendix 4.

Prior to April there was concern that the projection results were overly optimistic and that there was an unrealistic build-up of older fish – that projected recruitment was too high and natural mortality on the older ages too low. To address that, several additional OMs were suggested (Appendix 4). However, following the 5 April conference call, an error was detected in the code used for projecting the Pollock population into the future (see Appendix 4c). Essentially the value of natural mortality in the future had been set lower than intended. The consequence of this error was that the resource appeared to be more productive than is actually the case. As a result, appropriate Candidate Management Procedures (CMPs) were retuned (control parameter values re-selected) to be less aggressive than those advanced previously. The Chairs apologized for the error, and noted that the review process plays an important role in quality control; it was important that this error was rectified before the May RAP. This substantially influenced the decisions made for the Pollock MSE and this Proceedings records the impacts. However, resultant additional pressures of time meant that it was not possible to explore the implications of different degrees of doming in the commercial selectivity function to the extent originally planned (noting that in a recent USA pollock assessment, allowance for such doming had led to a more optimistic appraisal of resource status).

It is important to make clear that only Western Component Pollock (4Xopqrs+5Zc) was included in the MSE as this is the biological unit and the unit of assessment. This causes some confusion as the current management unit is 4X5; Fisheries Management will note and address this.

The objectives of this 9-10 May 2011 RAP meeting were to complete the Western Component Pollock MSE on which recommendations will be based for risk management of Western Component Pollock, and to identify where to focus future research efforts to provide the greatest improvements to management advice by:

- reviewing the runs of the Management Procedure simulation tests on the Reference Set of Operating Models (OMs) and other OMs established at the December 2010 workshop and subsequent telephone meetings;
- reviewing/revising options for objectives and harvest control rule(s) and confirming their adequate performance against all the OMs;
- providing advice on objectives, harvest control rules, a protocol for Exceptional Circumstances, on-going information-support requirements, and implementation processes with respect to adoption of MSE as a risk management approach for an appropriate period; and
- identifying where to focus future research efforts to provide the greatest improvements to management advice.

The Chairs noted that this Western Component Pollock MSE is the first live application of MSE in the Maritimes Region. The intensity of the process reflects this and the importance of both understanding MSE as well as the need to clearly communicate the process and the results to Science, Fisheries Management and Industry.

REVIEW THE DEVELOPMENT OF CANDIDATE MANAGEMENT PROCEDURES FOR WESTERN COMPONENT POLLOCK

Papers Presented

Doug Butterworth (co-authored with R. Rademeyer) presented a working paper "Results on the Development of Candidate Management Procedures for the Canadian Pollock in the in the Western Component (4Xopqrs+5Zc)". Results for several different Candidate Management Procedures for Pollock were presented. The CMPs contrasted achievable performance (catch *vs.* resource recovery and catch *vs.* time) trade-offs in relation to greater/lesser conservatism and earlier/later pain in terms of catch allocation reductions if needed. The results incorporated recent decisions concerning the reporting of performance statistics and the addition of further (OMs) which reflect better future recruitment.

The paper presented results for five alternative Candidate Management Procedures (CMPs) in forms that incorporate discussions at and following recent conference calls. Specifically:

- exploitable biomass B^{4-8} projections were also reported relative to their 1982-2010 average, and plots also showed lower 25%-iles;
- two new Operating Models were added, each reflecting better average future recruitment than observed over the last 10 years for which reliable estimates are available; and
- two further CMP tunings were added reflecting more (CMP_high) and less (CMP_low) conservative approaches than CMPR (see Appendix 4c).

Discussion

There were a number of points of clarification and the intent is that the Research Document will contain the level of detail required in order to make the calculations repeatable.

The key area of discussion was to achieve consensus on an appropriate choice among CMPs to provide a preferred trade-off between competing objectives. The CMPs for which results were projected in the working paper were chosen to illustrate two major trade-off axes. The first of these was the degree of conservatism, which trades off the level of catch in the medium term against the extent of resource recovery. The second trade-off was the earlier pain *vs.* later pain trade-off axis, whereby an immediate fairly large cut-back in catches can be avoided, but this would need to be followed by larger drop in catches later.

The author emphasized that the MP finally chosen does not need to be one of the CMPs for which results were presented in the working paper. In fact it was not, but discussion had to first focus on the desired trade-offs in performance. The illustration in the working paper made it possible to subsequently "tune" the CMP control parameters to make final decisions. This also provided the required context to refine the Management Objectives by showing the range of possibilities, *inter alia* by including the most optimistic possibility for resource recovery through considering projections with all future catches set to zero.

Given that biomass indices from the summer DFO research vessel (RV) survey for 1984-2010 provide the monitoring data used to update the MSE model catch limit calculations, the Catch Limit *vs.* Survey Index Ratio (J_y) plot was considered in detail, as it is key to the understanding of the process. J_y is the geometric mean of the RV Survey Biomass Indices over the last three years as a proportion of the geometric mean of the index value for 1984 to 1994 (this reference period was chosen as it represented the period of highest productivity during the available time series). It was noted that the output from this relationship may subsequently be modified to conform with restrictions on the extent to which the total catch allocation may change from one year to the next.

Concern was expressed about the changes in the weights at age and the influence on biomass. RV survey mean weights at age (equivalent to mid-year population weights-at-age) declined after the mid-1980s, although the pattern has been somewhat variable over the past decade, indicating a reduction in this aspect of productivity. If productivity is lower now compared to the past, it may not be possible to achieve population biomass levels comparable to the 1980s, even if catches are kept at low levels. Some text on this issue (with a Figure) was included in the Science Advisory Report (SAR).

It was noted that throughout the calculations that TAC is equated to catch, implying no implementation error.

General concern was expressed by the reviewer about the underlying biology/productivity, the assessment and information content of the survey:

- The productivity, because of changes to size at age, potential changes to natural mortality and the retraction of the resource into the western Scotian Shelf.
- The assessment, because of the VPA's extreme sensitivity to the 2010 survey value and its strong retrospective patterns.

These were not addressed directly during this Pollock MSE exercise; the intent was to use the existing information as the best that we have, recognizing that the MSE process is designed to deal with such uncertainties.

- It is recognized that Pollock, being a semi-pelagic, schooling species, are less well sampled by the summer RV survey when compared to other gadids. This creates high variability in the RV Survey Biomass Index from year-to-year. There are indications of a fairly recent increase in natural mortality, but little basis to infer for how long this might continue. Recruitment is highly variable, and this in combination with the high variability of RV survey results makes management difficult as resource declines can occur before this becomes unequivocally clear from the RV Survey Biomass Index trends.

The MSE process has, through its various OMs, attempted to capture most of this uncertainty so that the Management Procedure can be evaluated to give robust performance even given this lack of perfect knowledge.

Since the December workshop the suite of Operating Models has been revised. As stated in Porter and Docherty (2011), the major sources of uncertainty in the Pollock assessment model and projections arising from it include[1]:

- variability of RV surveys and hence in the relationship between the Survey Biomass Index and the underlying population abundance;
- changes in natural mortality (M);
- partial recruitment (PR) on older ages;
- high variability in recruitment (note that the last 2 years are poorly estimated); and
- stock recruitment relationship.

Four OMs (for a total of 17; Table 1) were added to the December list to ensure the OMs span the full range of plausible values. OM15 and 16 were added to address scenarios of higher natural mortality and low recruitment; OM16 and OM17 were added to encompass recruitment levels experienced over the whole period (back to 1984), not just the past 5 or 10 years, and thus provide better balance. All OMs employ the existing VPA-based assessments. It was noted that partial recruitment scenarios for older age fish were not explored fully at this time.

There was considerable discussion about the influence of the Reference Set. Since the detection of the error in the code and the subsequent change in the perception of the stock, it was felt that the RS established in December was not balanced. Although participants agreed that the same elements of uncertainty were still important to portray in the OMs and RS, for the stock/recruitment (S/R) element it was felt that OM13 was too extreme for the RS and that OM14 and OM17 better framed the uncertainty in stock recruitment relationship. In the December RS five of the six OMs used a more pessimistic S/R relationship – to achieve better balance in the revised RS, the OMs with S/R relationships that included Beverton-Holt (OM14) and the whole time series (OM17) were included. It is primarily against this RS that the performance of Candidate Management Procedures (CMPs) was evaluated.

Concern was expressed that all but one (OM3) of the 6 VPA formulations in the RS include the 2010 survey, which means that the median result for current biomass is very low, and the estimated recruitment values for recent years are very low. This formulation was considered more plausible for a variety of reasons. The survey values used for 2009 and 2010 are highly influential on the projections and have a marked impact on which CMP will best meet the objectives for the next five years.

[1] Utility of the catch per unit effort (CPUE) series (OM11) was not examined, though identified in the December 2010 workshop (OM11); it implied CMPs using CPUE as well as survey data and in the time available this was not considered a priority.

Table 1: Set of Operating Models (OMs) and Reference Set (RS; in bold) agreed to for the MSE application to 4Xopqrs5 Pollock.

Uncertainty	OM Characteristics*	Stock-Recruitment Relationship
Reference Case	1. RAD 1 (Rademeyer and Butterworth 2011): no bias correction, M = 0.2, including 2010 RV survey estimate	**Based on last 10 reliable years (1999-2008)**
RV Survey Variability and Relationship between RV Survey Index and Population Abundance	**2. Stone (Stone 2011): with bias correction, M = 0.2, including 2010 RV survey estimate**	**Based on last 10 reliable years (1999-2008)**
	3. Stone (Stone 2011): with bias correction, M = 0.2, excluding 2010 RV survey estimate	Based on last 10 reliable years (1999-2008)
	4. As OM1 but using square root function for RV survey abundance	Based on last 10 reliable years (1999-2008)
	5. As OM1 but using power (square) function for RV survey abundance	Based on last 10 reliable years (1999-2008)
	6. As OM1 but using mixture distribution for future RV survey abundance	Based on last 10 reliable years (1999-2008)
Changes in Natural Mortality	7. As OM1 but using M=0.2 for ages 6 or less, age 7-13 M=0.675 - no change in future	Based on last 10 reliable years (1999-2008)
	8. As OM1 but using M=0.2 for ages 4 or less, M=0.579 for ages 5 and 6 and M=0.617 for ages 7 and above - no change in future	**Based on last 10 reliable years (1999-2008)**
	9. M as in OM7 but back to 0.2 after 5 years	Based on last 10 reliable years (1999-2008)
	10. M as in OM8 but back to 0.2 after 5 years	Based on last 10 reliable years (1999-2008)
Partial Recruitment on older ages	12. As OM1 but using dome-shaped RV survey partial recruitment on older ages	Based on last 10 reliable years (1999-2008)
High Variability in Recruitment and Stock Recruitment Relationship	13. As OM1	Based on last 5 reliable years (2004-2008)
	14. As OM1	**Beverton-Holt, fit up to a maximum value corresponding to the average values for spawning stock biomass**
	15. As OM8	Based on last 5 reliable years (2004-2008)
	16. As OM1 but using M=0.2 for ages 6 or less, age 7-13 M=0.76 - no change in future	Based on last 5 reliable years (2004-2008)
	17. As OM1	**Based on all reliable years (1984-2008)**
	18. As OM1	Based on 1984-1994 period

* Note that #11 was eliminated from consideration.

PROVIDE ADVICE ON OBJECTIVES, HARVEST CONTROL RULES, A PROTOCOL FOR EXCEPTIONAL CIRCUMSTANCES, ON-GOING INFORMATION-SUPPORT REQUIREMENTS, AND IMPLEMENTATION PROCESSES WITH RESPECT TO ADOPTION OF MSE AS A RISK MANAGEMENT APPROACH FOR AN APPROPRIATE PERIOD

Management Objectives

The primary objective of the MSE approach is to find the CMP which offers what is considered to be the best trade-off in anticipated performance over the conflicting objectives of:

- maximising future catches (in both the short and the longer terms);
- minimising the risk of unintended resource depletion or (where pertinent) inadequate resource recovery; and
- minimising the extent of inter-annual TAC changes in the interests of Industry stability.

The CMP eventually chosen should not only be able to demonstrate this desired performance when tested under the RS of OMs, but also not show appreciable deviations from that performance for other "robustness test" OMs reflecting alternative plausible models of resource dynamics (*i.e.*, one seeks "robust" anticipated performance across the range of plausible OMs).

During the initial discussions in September 2010 (see Research Document) it was suggested that the following properties should be evaluated in a risk management context:

- the risk of decline of the exploitable biomass (ages 4 to 8) below the 2011 level be kept moderately low;
- the risk of annual average catch variation of greater than 25% be kept moderately low; and
- the magnitude of the average catch in the short term, medium term and long term be maximized.

These Management Objectives were updated during the December Workshop after choices were made among some of the variants considered (Porter and Docherty 2011):

- *ideal catch levels*: Catch of up to 10,000 t within a 3-5 year time period and 15,000 t within 10 years;
- *acceptable risk of unintended stock depletion:* Maintain a low (no more that 10%) risk of dropping below the 2000 biomass levels (calculated for each run) (the use of the 2000 SSB was decided as a reference given that this is a more precisely estimated value than those for more recent years, and was the lowest point in the time series); and
- *restrictions on annual TAC changes and maximum TAC*: Maximum change of 20% for all TAC levels and possible two-year TAC setting.

During the RAP, further refinements were made to the Management Objectives. Fisheries Management and Industry were tasked with these refinements. The Pollock MSE was a learning process and the participants wanted to express the Management Objectives in a results-based manner. Further, it was considered that they needed to be refined in light of the revised perception of the stock (after the coding error was corrected). The trade-offs between catch and sustainability was carefully considered.

The medium-term Management Objectives for Western Component Pollock MSE were selected for resource sustainability and catch, and constraints were selected for annual catch variability. The final medium-term Management Objectives for this MSE were:

- *sustainability:* The median of the ratio of the projected exploitable biomass ($B_{4\text{-}8}$) in 2021 to that in 2000 must be at least 1.5; the lower 25 percentile for this ratio must be at least 1;

- *catch*: Projections of median catch resulting from the Harvest Control Rule (HCR) must be greater than 4000 t for each of the next 5 years starting in 2012 (note that the projections assume that the catch taken each year is exactly as set); and
- *restrictions on annual catch changes and maximum catch*: Maximum annual catch increase of 20% or 500 t, whichever is greater; maximum inter-annual TAC decrease of 20% provided the geometric mean of the last three survey estimates remains at least 20% of the geometric mean over the 1984-1994 period (if this value drops below the 20% level, greater decreases are permissible); maximum annual catch of 20,000 t.

It is against these objectives that the performance of the Management Procedure (MP) is tested using the RS.

Concern was expressed by Science participants about the choice of Management Objectives:

- The Pollock CMPs that had been put forward permit some fishing even at very low biomass. The proportion of the biomass which could be caught increases as the population size declines (until it declines below the biomass at J_0). This seems to be contrary to standard conservation principles.
- The geometric mean survey biomass for a 10-yr period when biomass was high (1984-1993) is about 39,000 t for B_{4+} and 34,000 t for age B_{4-8}. Forty percent of the geometric mean survey biomass during the1984-1993 period is about 16,000 t for age B_{4+} and 14,000 t for B_{4-8}. These values could be considered a proxy for the Precautionary Approach (PA) Framework definition of lower reference point (LRP) = 40% spawning stock biomass (SSB) at maximum sustainable yield (MSY).
- The sustainability Management Objective (such that the median ratio of the projected exploitable biomass (B_{4-8}) in 2021 to that in 2000 must be at least 1.5) represents an increase from 7,400 t in 2000 to 11,100 t by 2010, which is lower than the LRP proxy of 14,000 t for B_{4-8}.
- This sustainability Management Objective appears to fall outside of the PA Framework, especially when there is so much uncertainty regarding the current (2010) biomass level (*i.e.*, somewhere between 9,500 and 22,300 t and probably at the lower end of the Cautious Zone).

It was noted that the selected objectives are a *management* choice about the best balance between the objectives.

In 5 years time, the MP will be reviewed and at that time questions like – Do we want more recovery? Do we want to invest more of the growth back into the biomass of the population? – can be asked. At that time the Management Objectives will be reviewed again, in particular the trade-offs between catch and sustainability.

Management Procedure and its Constituent Harvest Control Rules

The Harvest Control Rule is a consistent procedure used to set the catch limit following the annual receipt of the biomass estimate from the update of the Survey Biomass Index for the Western Component. Detailed formulae are provided in the Research Document. As such, the Management Procedure is based on the direct use of an annual biomass index from the results of the summer RV survey. The HCR provides a pre-defined means of changing the catch limit in response to the available observations from the RV survey, which is being used to monitor changes in the condition of the stock.

Following the revision to the Reference Set, the performance of various Candidate Management Procedures were recalculated. Seven CMPs were evaluated; the choice between them was

driven by the degree of desired conservatism, which traded off the level of catch in the medium-term against the extent of resource recovery. These seven CMPs and their performance statistics are detailed in the Research Document, with CMPH, CMPH+ and CMPD being the most conservative (Figure 1). The Pollock MP agreed upon was CMPInt+ in Figure 1, an intermediate choice. It was the only CMP that met all of the Management Objectives. The curve in Figure 1 shows the relationship between the catch limit output by the seven CMPs and the Survey Index Ratio.

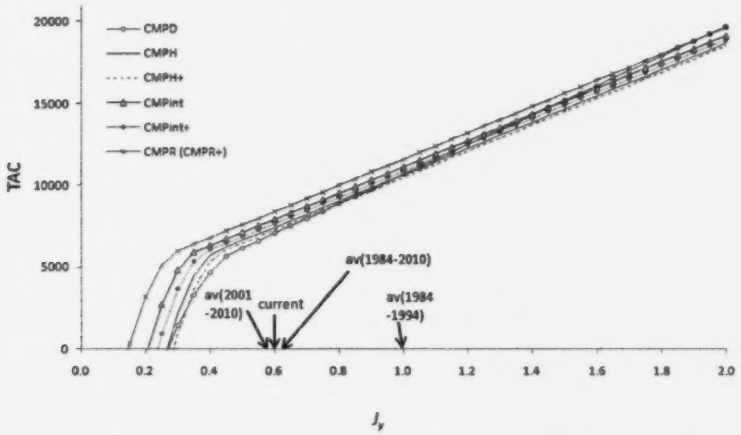

Figure 1: Relationship between the catch limit output by the seven CMPs and the RV Survey Index Ratio. The arrows indicate values of this ratio at other times or averaged over the periods indicated. Note CMPint+ was selected as the Pollock MP.

Although 20-year projections were used for the illustrative runs, the focus in the MSE, consistent with the Management Objectives, was on the first 10 years. This is a fundamental difference from the traditional Pollock VPA assessment for which only one or two year projections are conducted.

The CMPs included the following rules: If the RV Survey Biomass Index three-year running geometric mean (GM) dropped below 20% of the 1984-94 GM, the provision limiting catch reductions from one year to the next to 20% was modified to allow reductions up to 40%; if the GM dropped further to less than 10% of the 1984-94 GM, even greater reductions (including closure) become possible.

A robust MP produces outcomes that meet predefined Management Objectives under a core set of plausible scenarios that cover the most important uncertainties concerning the fishery. Each CMP was evaluated against the RS to produce performance statistics, such that a comparison of results against the Management Objectives was possible. Following a review of performance (Table 2), the final Pollock MP was selected as it represented the best performance against each of the Management Objectives (see bold in Table 2). Despite concerns from Science about the choice of Management Objectives, the participants agreed to proceed with the implementation of the Pollock MP and "try the experiment."

Table 2 also shows the 'no catch' scenario which provides a useful baseline illustrating the upper boundary of resource recovery expectations. Performance statistics for all seven CMPs are shown in the Research Document.

*Table 2: Projection results (median, with upper and lower 25 percentiles in parentheses) for a series of performance statistics for no catch and the Pollock MP under the RS. Figures in **bold** relate to satisfying the Management Objectives (C=catch, B=biomass).*

Performance statistics	No catch		Pollock MP*	
$B^{4-8}_{2021}/B^{4-8}_{2000}$	3.52	(2.45; 4.53)	**1.67**	**(1.01; 2.54)**
$B^{sp}_{2021}/B^{sp}_{2000}$	8.70	(5.93; 10.65)	2.16	(1.26; 3.93)
$B^{4-8}_{2021}/B^{4-8}_{2010}$	2.12	(1.64; 3.10)	1.10	(0.61; 1.84)
$B^{4-8}_{2021}/av(B^{4-8}_{1982-2010})$	1.26	(0.97; 1.58)	0.63	(0.38; 0.94)
C_{2011}	6000	(6000; 6000)	6000	(6000; 6000)
C_{2012}	0	(0; 0)	**5373**	(4800; 6289)
C_{2013}	0	(0; 0)	**4786**	(3840; 6280)
C_{2014}	0	(0; 0)	**4608**	(3046; 6912)
C_{2015}	0	(0; 0)	**4441**	(2351; 7086)
C_{2016}	0	(0; 0)	**4381**	(2037; 7249)
$C_{2011-2020}$	600	(600; 600)	4677	(3249; 6609)

* Referred to as CMPint+ in the Research Document

The HCR (shown in detail in the Research Document) associated with this MP will be used as the annual catch limit-setting mechanism following the completion of the RV survey. If a RV survey does not occur in one year, the average of the last two data points will be applied; two consecutive RV surveys missed constitutes an Exceptional Circumstance (see below).

Figures were included in the SAR to illustrate:

- The median catch and exploitable (ages 4 to 8) biomass relative to 2000 level for no catch and the Pollock MP applied to the RS. The values of the Pollock MP median curve for total catch over 2012 to 2016 show that the catch-related Management Objective of values above 4000 t are met for that period. Similarly the Pollock MP curves showed that in 2021 the two sustainability related management objectives are met.
- The projected distributions of the Survey Biomass Index for each future year, with a 90% probability interval within which the RV survey result is projected to lie. Provided the result falls inside such an interval, there is no evidence that the actual situation is outside the range of circumstances considered in the testing, and for which the MP is considered to be adequately responsive. However, if a result falls outside this interval, that would be grounds for deciding that Exceptional Circumstances apply (see below).

Exceptional Circumstances Protocol

The MP, once adopted, should be applied in autopilot style, *i.e.*, given the new monitoring data required for an updated catch limit calculation (the latest RV Survey Biomass Index in the case of Pollock), the MP formula to compute the catch limit should be applied automatically, and the result put into place by decision-makers.

Exceptional Circumstances provisions are intended to cover situations outside the range for which the MP was simulation tested (correspondingly beyond situations that the autopilot was designed to handle). In such cases the decision-maker has reasons to stop the automatic application of the MP and perhaps to amend the catch limits set by the MP or also require the MP to be revised. This should not be a frequent occurrence – certainly an anticipated average rate of less than once per decade – and accordingly, compelling evidence should be required to invoke such provisions. There was a thorough discussion of the Exceptional Circumstances criteria – there was a balance of being conservative enough to give a level of comfort in this our first venture into MSE, and ensuring that we are not too conservative so as to trigger an

Exceptional Circumstance too soon. The following elements were agreed to and reported in the SAR:

When exceptional circumstances are detected, three courses of action are possible depending on the degree and type of the circumstance observed. In descending order, they would be considered as follows:

1. review the information, but maintain the MP as the management mechanism - additional research/monitoring may be recommended to determine if the signal detected warrants moving to step 2;
2. advance the review period, and potentially revise the MP, but implement the MP outputs; and
3. set a catch limit that departs from the MP, and revise the MP.

The main reasons for deciding that such circumstances should apply would be either unexpected results (positive or negative) arising from monitoring data; or evidence becoming available that the true situation of the resource/fishery/monitoring differed (better or worse) from that envisaged by the Operating Models used for the testing.

The sources of data that could be used for this purpose are RV Survey Biomass Index results, and the average age, and age structure of the catch and/or RV survey.

Results that will trigger an Exceptional Circumstance review:

1. if the RV Survey Index Ratio (J_y) is <0.2, or outside the 90% probability interval within which the RV survey result is projected to lie; and
2. if the RV Survey Biomass Index is <6 kg/tow for two consecutive years.

Additional situations that would trigger an Exceptional Circumstance review:

- the RV survey not taking place or being substantially curtailed or changed, for two consecutive years;
- catches, including estimated discards, appreciably exceeding the limit set by the MP;
- an important change in the fishery and population age structure (compressed or expanded) as reflected in the fishery catch at age and the RV survey age-specific indices of abundance (this could also imply changes in selectivity patterns beyond those assumed);
- an important change in understanding of the biology assumed for the Operating Models, *e.g.*, ageing found to have been biased, or the estimated age at maturity substantially in error;
- commercial catch is <0.75 MP-derived catch - are there reasons other than abundance decline?; and
- evidence that there is a substantial biomass increase in the Western Component not captured by the summer RV survey.

Information-Support Requirements and Implementation Process

An annual review will determine if the RV Survey Biomass Index has moved outside projected ranges.

Unless an Exceptional Circumstance is triggered, the application of the MP will provide the catch limit for Western Component Pollock. The expected operating timeframe for this MSE is 5 years, after which there will be a thorough review. This may result in a revision to the MP.

The steps and process associated with the application of the Pollock MP will be detailed by Fisheries Management in a document associated with the Integrated Fisheries Management Plan.

RESEARCH RECOMMENDATIONS

Research topics that would have the greatest impact to improve the MSE are: firstly investigate methods to reduce the variance in the RV survey, and secondly to both improve estimates of natural mortality and determine the causes of the relative absence of older fish in the catch and RV survey.

Other research topics include: better defining stock boundaries (possibly using high-tech tags); better detecting year classes, in particular juvenile pollock; better understanding changes in weights at age and growth across species (by considering environmental drivers).

However, clear analyses of the investment required for and the potential benefits to be obtained from such research should be made. The MSE process is designed to deal with such uncertainties.

SUMMARY AND CLOSING

The MSE for 4Xopqrs5 Pollock (Western Component) is the result of a year-long process that brought together a project team composed of DFO Science, DFO Management, Industry representatives and outside experts. This is a technical exercise and if DFO wishes to use MSE in the future for other fisheries, internal capacity should be developed.

It was concluded that the MSE developed for Western Component 4Xopqrs5 Pollock is sufficiently robust to plausible uncertainties, and if the selected MP is employed, will result in an acceptable trade-off between the three Management Objectives. The MP selected should be used to derive management advice and guide management decisions, unless any of the above-noted Exceptional Circumstances are deemed to apply. The expected operating timeframe for this MSE is 5 years, after which there will be a thorough review. This may result in a revision to the MP.

At the conclusion of the meeting there was consensus on the main elements of the MSE contained in these Proceedings. The meeting concluded with a draft SAR and summary bullets. It was agreed that the SAR drafting would be completed by a small team (Porter, Leslie, Stone, Clark and Butterworth) and sent to the participants for comment and to achieve consensus around the end of May. Given that this is a new process, it was agreed that the SAR would be fairly detailed in order to include background on MSE.

The Co-Chairs thanked the participants for an extremely productive meeting and for their dedicated involvement since autumn of 2010, and congratulated them on the successful outcome. It was an excellent example of Science, Fisheries Management and the Industry working together. Doug Butterworth was thanked for his excellent efforts and clarity of presentation (and patience). Rebecca Rademeyer was thanked for clear and rapid feedback of computations requested during the course of the meeting. Heath Stone was thanked for his attention to detail and tenacity throughout the process, which turned out to be so important for quality control. It was noted that Bruce Chapman inspired the exploration of a MSE for pollock and facilitated it with substantial funds from the Groundfish Enterprise Allocation Council

(GEAC). GEAC's level of commitment was commended. Bruce Chapman thanked the Chairs for guiding participants through a difficult but very productive process.

The meeting adjourned at 3:30 PM, 10 May 2011.

SOURCES OF INFORMATION

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Rademeyer, R.A., and Butterworth, D.S. 2011. Progress on the development of Candidate Management Procedures for the Canadian Pollock in the western component (4Xopqrs+5Zc); pp. 115-134. *In*: J.M. Porter and V. Docherty, Chairpersons. Proceedings of 4X5 Pollock Management Strategy Evaluation Workshop – 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2945.

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Appendix 1: Agenda

Western Component Pollock (4Xopqrs5) Management Strategy Evaluation
Maritimes Regional Science Advisory Process

9-10 May 2011

Hachey Conference Centre
St. Andrews Biological Station
531 Brandy Cove Road, St. Andrews NB

AGENDA

Monday, 9 May 2011

08:30-08:45	Welcome and Introductions (Co-Chairs: Julie Porter and Stefan Leslie)
08:45-10:00	Review the development of Candidate Management Procedures for 4X5 Pollock (Rebecca Rademeyer and Doug Butterworth)
10:00-10:15	Break
10:15-11:15	Review/revise options for objectives and harvest control rule(s) and the basis for selection amongst them (Doug Butterworth and Stefan Leslie)
11:15-12:00	Discussion of draft protocol for exceptional circumstances (Doug Butterworth, Stefan Leslie and Julie Porter)
12:00-13:00	Lunch (provided)
13:00-15:00	Provide advice on objectives, harvest control rules, a protocol for exceptional circumstances, on-going information-support requirements, and implementation processes with respect to adoption of MSE as a risk management approach for an appropriate period (Porter, Leslie)
1500-1515	Break
15:15-17:00	(Continued) - Provide advice on objectives, harvest control rules, a protocol for exceptional circumstances, on-going information-support requirements, and implementation processes with respect to adoption of MSE as a risk management approach for an appropriate period

Tuesday, 10 May 2011

08:30-09:30	Identify where to focus future research efforts to provide the greatest improvements to management advice.
09:30-12:00	Discussion and review draft SAR
12:00-13:00	Lunch (provided)
13:00-15:00	Complete SAR
15:00-15:30	Summary and Closing

Appendix 2: Terms of Reference

Western Component Pollock (4Xopqrs5) Management Strategy Evaluation

Maritimes Regional Science Advisory Process

9-10 May 2011
St. Andrews NB
http://www.mar.dfo-mpo.gc.ca/sabs/

Co-Chairs: Julie Porter and Stefan Leslie

TERMS OF REFERENCE

Context

There has been consideration by Fisheries Management (FM) and industry to manage Pollock in 4Xopqrs+5Zc using more of a risk management approach. In July 2010, FAM discussed a Management Strategy Evaluation (MSE) approach with Science and industry, with management objectives and harvest control rules specified up front. In December 2010 the approach began with a process to explore the existing assessment model (VPA), to understand the sources of uncertainty by running sensitivity analyses for a plausible range of variables for the key areas of uncertainty, and evaluating their impact on both utilization and sustainability objectives.

The 4Xopqrs+5Zc Pollock Management Strategy Evaluation (MSE) Workshop was held 9-10 December 2010, at the St. Andrews Biological Station, St. Andrews, New Brunswick (Porter and Docherty 2011). Participants included DFO staff (Science and Fisheries Management branches), Industry, and external experts. The objectives of the workshop were to gain a better understanding of the MSE process and to progress towards development of a structure on which recommendations will be based for risk management of 4X5 Pollock. A set of 12 Operating Models was agreed upon. Industry and Fisheries Management participants agreed to several management objectives to be evaluated in the MSE. A 5-month workplan was established. It was agreed that the next step would be a RAP meeting.

Objectives

The objective of this RAP meeting is to complete the 4Xopqrs+5Zc Pollock MSE on which recommendations will be based for risk management of 4Xopqrs+5Zc Pollock, and to identify where to focus future research efforts to provide the greatest improvements to management advice.

- Review the runs of the Management Procedure simulation tests on the Reference Set of Operating Models (OMs) and other OMs established at the December 2010 workshop;
- Review/revise options for objectives and harvest control rule(s) and validate on all OMs;
- Provide advice on objectives, harvest control rules, a protocol for exceptional circumstances, on-going information-support requirements, and implementation processes with respect to adoption of MSE as a risk management approach for an appropriate period; and
- Identify where to focus future research efforts to provide the greatest improvements to management advice.

Expected Publication

CSAS Science Advisory Report
CSAS Proceedings
CSAS Research Document

Participation

DFO Science, Maritimes
DFO FAM, Maritimes
Industry Representatives/Experts
International MSE Experts

References Cited

Porter, J.M., and Docherty, V., Chairpersons. 2011. Proceedings of 4X5 Pollock Management Strategy Evaluation Workshop – 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2945: iv + 158 p.

Appendix 3: List of Participants

Name	Affiliation
Andrushchenko, Irene	DFO Maritimes / SABS
Butterworth, Doug	Univ. Capetown
Chapman, Bruce	GEAC
Clark, Don	DFO Maritimes / SABS
Claytor, Ross	DFO Maritimes / PED
d'Entremont, Alain	GEAC/ MG ITQ
Docherty, Verna	DFO Maritimes / FM
Gross, Eric	DFO Maritimes / SABS
Hubley, Brad	DFO Maritimes / PED
Leslie, Stefan	DFO Maritimes / FM
McIntrye, Tara	Maritimes Advisory Services
Mohn, Robert	DFO Maritimes / PED
Paul, Stacey	DFO Maritimes / NSERC Capture Fisheries Network
Porter, Julie	DFO Maritimes / SABS
Rademeyer, Rebecca	Univ. Capetown
Stone, Heath	DFO Maritimes / SABS

Appendix 4. Records of Conference Calls

4a. Pollock MSE Meeting 14 February 2011, by Conference Call

1. WELCOME AND INTRODUCTIONS

Attendees: Julie Porter (Chair), Heath Stone, Alex Hanke, Verna Docherty, Stefan Leslie, Doug Butterworth, Rebecca Rademeyer, Alain D'Entremont, Bruce Chapman, Ross Claytor, Brad Hubley.

The intent of this meeting is to provide an initial impression of the sorts of results to be expected from the Canadian Pollock Management Procedure development process (MSE) agreed at the December 2010 workshop (Porter and Docherty 2011). A number of Candidate Management Procedures (CMPs) are developed which yield anticipated performances broadly within the range for objectives set out at that St Andrews meeting. The aims are to enhance the familiarity of participants with the types of outputs which the MSE process provides, and to obtain feedback to facilitate refinements as the process is then taken further forwards to the May 2011 RAP meeting.

2. REVIEW OF INTERIM ANALYSES

The interim analyses following the guidelines developed at the December 2010 workshop (Porter and Docherty 2011) was reviewed:

> Rademeyer, R.A., and Butterworth, D.S. February 2011. Further Progress on the Development of Candidate Management Procedures for the Canadian Pollock in the in the Western Component (4Xopqrs+5Zc).

D. Butterworth provided an overview of the projection results for the CMPs using the Reference Set (RS) of VPA runs established in the December 2010 workshop. The Procedures were tuned to yield performances in the range sought by that meeting.

It was clarified that implications of tuning to a median catch of 10,000t *vs.* 15,000t in 2016 can be seen in trade off between total catch, SSB and exploitable B (*i.e.*, higher SSB and exploitable B with lower median catch scenario). Target-based CMPB1 approach is more aggressive at rebuilding than CMPB2 because of tuning to lower catch in 2016. The purpose of the robustness test was to examine the influence of the more pessimistic recruitment strategy (*i.e.* Rob3) independently of the RS and its constituent Operating Models (OMs) selected in December. This approach could also be used as a means to examine the effects of higher M on older ages.

It was agreed that the RS would not be changed. However, there were recommendations for additions to the OMs to expand the robustness testing. There was concern that the projection results were overly optimistic and that there is an unrealistic build-up of older fish – that projected recruitment was too high and natural mortality on the older ages too low. To address that, the following additional OMs were suggested: a robustness test (an additional OM) will be added to investigate the combined effects of OM8 (higher M on age 5-6 and 6-13 as estimated in the VPA) and OM 13 (poorer recruitment from S-R relationship using last 5 years of reliable recruitment information); H. Stone will look into developing a range of M values that could be used in additional OMs, possibly even higher than the value of 0.68 estimated for age 7+ from the VPA (*i.e.*, as in OM8). ***Participants were encouraged to think of other scenarios and refinements, and develop and discuss these by e-mail.***

3. NEXT STEPS

Following the "Next Steps" in the Rademeyer and Butterworth paper it was noted that further work in this process will involve refining the CMPs to better address the agreed objectives for the fishery, and testing them against the complete set of OMs agreed at the December 2010 meeting in St Andrews (plus any others identified – see above).

- Refinement of the structure of the CMPs focus on the target-based approach because of the lesser variability in the annual TACs to which it leads without compromising other objectives.
  - There was discussion to provide clarification on slope-based *vs.* target-based CMPs. While both are based on survey information, target-based models show less TAC variability. All were in agreement that target-based CMPs are the best approach to use.
- Explore further the trade-offs involved in reducing the maximum inter-annual TAC change permitted below 20%?
  - It was agreed to explore both 20% and 15% changes in TAC, but not go below 15%.
- Do any of the management objectives set out during the December meeting merit revision in the light of the results discussed at this meeting?
  - Industry emphasized that exploitable biomass as a management objective is a more measurable objective, but that the effect on SSB could still be examined. It was agreed to continue to report on the results of both age 4-8 biomass (exploitable biomass) and 4+ biomass (spawning stock biomass (SSB)).
  - Industry agreed that tuning to 15,000t in 2016 ramps up the catch too quickly and suggested that this be adjusted downwards. Once results of additional robustness tests have been examined, the maximum catch can be established.
  - We may want to revise what is considered the low point for risk (the level below which we do not want to drop to) - currently it is the 2000 age 4+ biomass (7,500 t for the Reference Case OM) estimated by the VPA. Perhaps there is another measure that could be used. ***This lower reference point will be explored by e-mail. H. Stone recommended that the Reference Point bilateral (FAM/Science) for Western Component Pollock that is currently scheduled for 19 April be rescheduled to an earlier date.***
- Given that the possible first implementation of the MP formula to yield a TAC recommendation would be for 2012, should future calculations involve fixing a likely catch for 2011?
  - For the western component (this exercise), the catch for 2011 will be fixed at 5000t.
- How large a difference between the 2012 TAC and a likely 2011 catch should be allowed?
  - The 2012 catch will be a maximum of 7,500t.

4. REVIEW OF TERMS OF REFERENCE FOR 9-10 MAY 2011 RAP.

This will be done by e-mail.

5. CLOSE

The Chair thanked the participants. Participants can expect to receive a meeting summary, a "doodle poll" to establish the next conference call (in 3-4 weeks or so), and a revised paper from Rademeyer and Butterworth. The group agreed to correspond by e-mail to refine further OMs for expanding robustness testing, and regarding the reference point calculations.

6. REFERENCES

Porter, J.M., and Docherty, V., Chairpersons. 2011. Proceedings of 4X5 Pollock Management Strategy Evaluation Workshop – 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2945: iv + 158 p.

4b. Pollock MSE Meeting III, 5 April 2011, by Conference Call

1. WELCOME AND INTRODUCTIONS

Attendees: Julie Porter, Heath Stone, Don Clark, Kirsten Clark, Eric Gross, Ross Claytor, Peter Hurley, Brad Hubley, Bob Mohn, Tara McIntyre, Cyril Boudreau, Stephan Leslie, Doug Butterworth, Rebecca Rademeyer, Alain D'Entremont, Bruce Chapman.

Intent of Meeting: To review progress on the development of Candidate Management Procedures for Western Component Pollock since the last conference call on 14 February 2011 where the group made a number of recommendations/modifications. This is in preparation for the 9-10 May RAP.

2. REVIEW OF MSE RUNS REQUESTED DURING 14 FEBRUARY

D. Butterworth provided an overview of recent progress on the development of candidate management procedures for Western Component Pollock. Management Procedure testing was continued with the introduction of further robustness tests and the inclusion of a penalty term in the TAC formula if the survey abundance estimates fall below a threshold level. The new analyses following the guidelines developed at the December 2010 workshop (Porter and Docherty 2011) and the 14 February conference call were reviewed:

> Rademeyer, R.A., and Butterworth, D.S. April 2011. Report on ongoing Progress in the Development of Candidate Management Procedures for the Canadian Pollock in the in the Western Component (4Xopqrs+5Zc).

Updates now incorporated are:

1) the catch in 2011 is assumed fixed at 6000t.
2) a further statistic is reported: the probability of falling below $2xB_{2000}$ over the projection period (for both age 4-8 and 4+ biomass).
3) 2 further OM/robustness tests were constructed: in OM15 the natural mortality of fish age 5 and above is as in OM8 with the stock-recruitment relationship is based on the last 5 reliable years (instead of 10); in OM16 the natural mortality of fish of age 5 and above is fixed even higher at 0.76 from 1996 onwards and the stock-recruitment relationship is based on the last 5 reliable years.

- The revised CMPs include the additional OMs in the RS, and were tuned to 2016 median catches of 8,000t, 10,000t and 12,000t. All procedures adjust the catch up or down depending on modelled future (i.e., 2011-2021) annual survey results relative to the actual average value for 1984-1994, a period of high productivity. Some of the runs also included

an additional penalty function (similar to a LRP) which was based on trends from predicted future survey results. The additional penalty is applied when survey biomass falls below a pre-specified threshold level. This penalty term does improve performance in terms of resource conservation risk for both the Reference Set of Operating Models and the robustness tests examined, though the improvement is slight even for relatively large sacrifices in catch. Model results indicated that there was not much difference in median catches between CMPs with and without the penalty function however, the lower 2.5 percentile was considerably lower for the model with the penalty function. Performance statistics in Fig. 8 show that the lower percentile for catches is brought down for CMPs that have an additional penalty term. The ROB3 OM has lowest catches as expected since this model has recruitment at the lowest level that occurred in the past for the next eight years.

- CMPe1a was considered to be the best management procedure formulation in terms of controlling risk and providing adequate catch. Compared to "no catch at all" this was one of the candidate procedures that did not look too bad, providing (in the authors' view) the best trade-off between risk and reward.

- There was discussion about whether the dynamics of Western Component Pollock are correctly specified by the new CMPs and that the projections are overly optimistic (Appendix 4b1). The detailed explanation by Doug Butterworth helped build confidence in the procedure. In addition the following steps will be taken:
    - Add a new OM: ROB3 + OM15 combination
    - Do a practical application to demonstrate how the CMP responds to a number of survey scenarios. This will allow the group to see an illustration of feedback.
    - Compare input data and results from H. Stone VPA projections for 2011-2020 with those of R. Rademeyer for MSE model projections to ensure consistency in approaches and check for possible coding errors.
    - In actual operation, the proportion of fish aged 7+ from the CAA and the survey would also be examined annually; however if this falls outside the 95% probability envelope predicted in the simulation tests (i.e., an exceptional circumstance), then a benchmark review may be triggered to re-examine the management procedure adopted.

- The trade-offs involved in reducing the maximum inter-annual TAC were further explored. There is minimal increase in resource risk if reducing the interannual TAC change constraint from 20% to 15%. It was agreed that a ± 15% risk for TAC change is acceptable to industry.

3. NEXT STEPS

a) Conduct an additional robustness test using ROB3 coupled with high M (OM15) - this would be a worst case scenario. [***Action*: Rademeyer and Butterworth**]

b) Create a series of survey values for the 2011-2020 periods to test the harvest control rule and the impact it has on adjusting the TAC either up or down. These series could have several patterns, i.e., Ref (average biomass for 1984-1994), ½ Ref, 2XRef, 1/3 Ref increasing + 2XRef + 1/3 Ref decreasing, steady increase, steady decrease etc. These results will be circulated for immediate feedback and will hopefully provide some comfort that the management procedure examined in the MSE is responding sensibly to results from the survey. [***Action*: Stone and Rademeyer** immediately]

c) Compare input data and results from H. Stone VPA projections for 2011-2020 with those of R. Rademyer for MSE model projections to ensure consistency in approaches and to check for possible coding errors. For the Pollock assessment, a plus group is not used and the

catch at age is for ages 2-13. If the MSE model uses a plus group, it may be causing an accumulation of older fish than seen in the VPA. The impact of S/R and higher M has already been examined so a "plus group" may be causing the difference in our projection results. [***Action*: Stone and Rademeyer** immediately]

d) It is proposed that there be a conference call with Porter, Butterworth, Rademeyer and Stone (and possibly Leslie) during the week of 11 April to evaluate results of b) and c) above and to determine if a conference call with the full group is required before the May RAP. [***Action*: Porter, Butterworth, Rademeyer, Stone**]

e) The group will need to draft a set of "exceptional circumstances" before the May RAP meeting. D. Butterworth will provide an example of how this was done for South African Hake and we can decide what elements we want to include for the Western Component Pollock MSE. [***Action*: Porter** to circulate the South African Hake example; **Butterworth** to provide initial suggestions of how this example might be modified for the Pollock case before the 9-10 May meeting.]

4. REVIEW OF PLANS FOR 9-10 MAY 2011 RAP.

a) Butterworth and Rademeyer will prepare a comprehensive working paper for the May RAP. This will become a Research Document in the CSAS series (requires specific formatting and review post-meeting). [***Action*: Rademeyer and Butterworth**]
b) Prepare agenda for the May RAP. [***Action*: Porter and Leslie**]
c) Discuss the content and organization of the Stock Advisory Report (SAR) as this is the first use of MSE in a RAP and SAR in Maritimes Region. Stone (Science) and Docherty (FM) will prepare a draft SAR before the May meeting with the Guidance of the Co-Chairs (Porter and Leslie) and the CSA office (McIntyre). [***Action*: McIntryre** set-up meeting week of 11 April to discuss]

5. CLOSE

While there were additional questions of a technical nature, in the interest of time the Chairs asked that they be followed-up by e-mail; participants were encouraged to do a "reply-all" so the whole group could be included.

The Chairs thanked the participants. Participants can expect to receive the practical illustration to demonstrate how the CMP responds to a number of survey scenarios within a week. Following feedback from the group, Chairs will determine if a further group conference call is required before the May RAP. There was general agreement that if we can resolve any code issues and see the practical illustration, that we can have a workable Candidate Management Procedure for the May RAP.

6. REFERENCES

Porter, J.M., and Docherty, V., Chairpersons. 2011. Proceedings of 4X5 Pollock Management Strategy Evaluation Workshop – 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2945: iv + 158 p.

APPENDIX 4b1. HEATH STONE'S COMMENTS ON THE WORKING PAPER PRIOR TO THE CONFERENCE CALL

My comments on the updated Candidate Management Procedures recently provided by Rebecca and Doug are similar in nature to the ones I made for the February 14 conference call. Although I may not have correctly understood/interpreted their results (I find them confusing), I still do not think that the dynamics of Western Component Pollock are correctly specified by the new Management Procedures (CMPc1a-c and CMPe1a-c), all of which use the new Reference Set of Operating Models, some of which are fairly conservative.

What concern me are the trajectories for Total Catch, Bsp and B4-8 (Figs. 1 & 3) before and after 2011 (separated by the vertical dashed line). For example, by 2015, Bsp increases to over 50,000 t and B4-8 to 40,000t and at same time the Total Catch increases to ~ 10,000t. How does Bsp increase so quickly when catches are ramping up at the same time? Is M still too low (resulting in a build-up of older fish) and is the S/R too optimistic? Perhaps the less optimistic OMs in the RS get downweighted through the averaging process in the CMP model so that the end result is that we see the outcome in the lower 2.5 percentile but not the median. Perhaps we should not use a RS but instead base the model on our current view of stock productivity at this time (i.e. high M and low recruitment as in OM16 or ROB3).

The past history of the 4Xopqrs5 stock based on VPA estimates indicates that 4+ B has never exceeded 65,000t during 1982-2010 time series. The estimate of 65,000t was for 1984 when the VPA had converged and would not be influenced by survey results. In the 1990s when landings were in the 10,000t -16,000t range, catches were not sustainable, exploitation levels were high (60%), and the age 4+ biomass declined rapidly to the low level of 7,500 t in 2000.

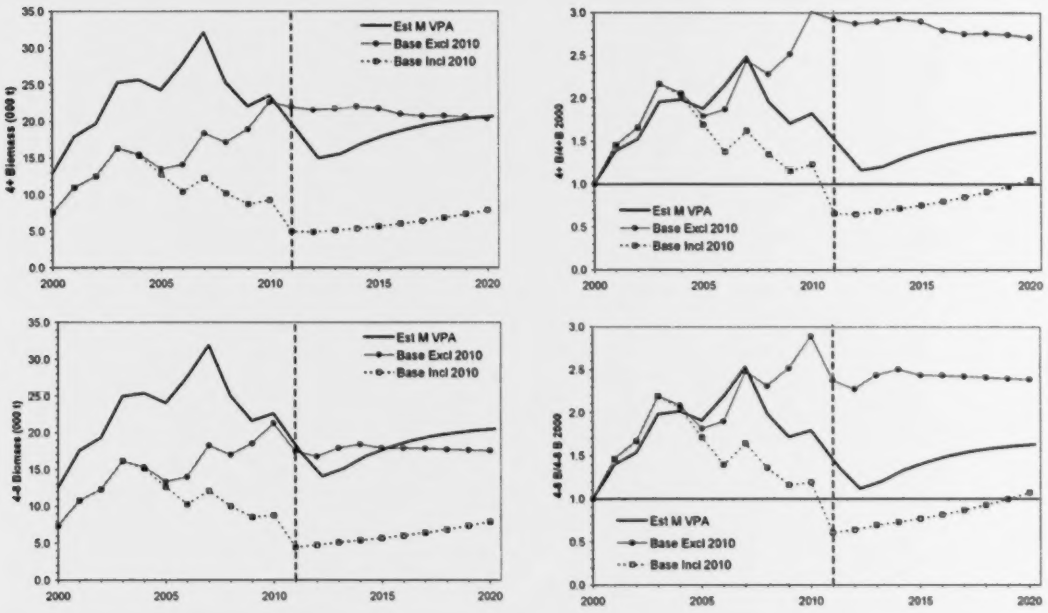
For illustrative purposes, I have conducted some simulations using the ADAPT VPA formulations (bias adjusted) for the Base VPA runs which include and exclude the 2010 RV index as well as the model which estimated M (Figure 1). These are essentially three of the OMs in the RS. For the base model runs, I have projected the 4+ biomass and age 4-8 (exploitable) biomass to 2020, assuming that the catch in each year will be 6000 t and recruitment will be 5 million. I had to reduce the catch to 5000t/year for the model which includes the 2010 RV, because for some ages the catch exceeded population abundance. Projections for the VPA model that estimates M assumed a catch of 6000 t/yr, 8 million recruits/yr and M=0.58 for ages 5-6 and 0.62 for age 7-13.

The main point here is that the 4+ biomass and the 4-8 biomass trajectories based on these VPA projections do not show the dramatic increases illustrated by CMpc1a-c and CPMe1a-c. For the Base model excluding the 2010 RV, the biomass trajectory remains flat (~22,000t) from 2011-2020 at catches of 6000t. For the model which included the 2010 RV, biomass remains very low at catches of 5000t, increasing from 5000t to 8000t from 2011 to 2020. (Note that for this model the biomass trajectory falls well below the B 2000 reference level). For the model with high M at catches of 6000t, biomass increases gradually from 15,000 t in 2011 to 21,000t in 2020 and if exteneded further in time would probably remain in equilibrium at this level. So the question is: what is different in the MSE models that generate scenarios that are much more optimistic/productive than illustrated by these VPA projections?

Some additional comments follow:

- The Results using OM16 are somewhat puzzling (M = 0.76 for ages 7+ and low recruitment for past 5 years), and I wonder why the performance statistics in Fig. 8 come out as high as the RS?

- I am assuming that the 1:1 reference lines in Figs.1 -4 are based on B2000 (=7,500 t). If so, this is probably too low for a precautionary approach LRP and should be at least two times this value (i.e. 15,000t), since proxies for 40% BMSY from RV survey and stock-recruit models indicate LRP values ranging from 16,000-22,000t for the western component.
- The future "reality" checks" for proportion age 7+ in the catch should be based on actual CAA data from fishery and RV survey and not model predictions.



Appendix 4b Figure 1. Bias adjusted VPA projections for 4+ biomass (top panels) and 4-8 (exploitable) biomass (lower panels) for 2011-2020 from models which include and exclude the 2010 RV indices and a model which estimates M on age 5-6 and 7-13. The panels on the left illustrate trends in tonnes, while the panels on the right illustrate trends relative to 4+ population biomass in 2000 (7,500 t, the lowest level in the 1982-2010 time series).

4c. Pollock MSE Meeting IV, 21 April 2011, by Conference Call

1. WELCOME AND INTRODUCTIONS

Attendees: Julie Porter, Heath Stone, Don Clark, Kirsten Clark, Eric Gross, Peter Hurley, Brad Hubley, Tara McIntyre, Cyril Boudreau, Stephan Leslie, Verna Docherty, Doug Butterworth, Alain D'Entremont, Bruce Chapman

Intent of Meeting: To review the results of Pollock CMP reruns following changes to the projection code. Since the last conference call (5 April) an error was detected in the code used for projecting the Pollock population into the future. Essentially the value of natural mortality in the future had been set lower than intended. The consequence of this error was that the resource appeared to be more productive than is actually the case. As a result, appropriate CMPs were retuned (control parameter values re-selected) to be less aggressive than those advanced previously. The Chair apologized for the error, and noted that the review process plays an important role in quality control.

2. REVIEW OF RETUNED CMPS (includes illustrative applications of the CMP to a series of future survey results)

D. Butterworth provided an overview following detection of a coding error that set natural mortality too low in previous projection results reported, and hence provided overoptimistic results for Candidate Management Procedure (CMP) testing, CMPs have been retuned to more conservative levels to provide an improved risk-reward trade-off. The Reference Set (RS) of Operating Models (same as established in December 2010 - Porter and Docherty 2011) now proves a quite stringent test, as even in the absence of future catches, the exploitable biomass can drop below its 2000 level. Results for three CMP variants are shown. While all can yield high catches if the survey abundance index increases, under the RS future surveys are predicted to mainly be low in the immediate future, so that in median terms future TACs over the next decade would average in the 4000 to 5000 range under these CMPs. Furthermore the 20% cap on interannual TAC reductions needs to be relaxed if the survey results drop to very low levels to be able to reverse resource declines.

The corrected analyses following the guidelines (and the same Reference Set) developed at the December 2010 workshop (Porter and Docherty 2011) and the 14 February and 5 April conference calls. The document presented was as follows (see also Appendix 4c1):

Rademeyer, R.A., and Butterworth, D.S. April 2011. An Update on the Development of Candidate Management Procedures for the Canadian Pollock in the in the Western Component (4Xopqrs+5Zc).

- Results from Figure 1 of the WP (catch and survey biomass trajectories for a series of future survey scenarios) were discussed and illustrated the response of the model after revisions to the projection code. In cases where RV results are poor, the TACS are now much lower than they were before the code was changed.
- Using a 3-year running average, the model response is dampened on the way up and the way down (thereby reducing some of the high annual variability in the time series); because the survey time series is quite noisy (CV=75%) with a large signal to noise ratio, there is a trade-off between following the signal *vs.* the noise.
- In order to be more cautious, it has been necessary to use ± 20 % TAC variability rule to limit how fast the TAC will increase (up to a 20,000t cap) or decrease.
- There was a discussion on how to take age composition into consideration in the CMP. D. Butterworth suggested that when using ages "split out" there can be problems due to an increasing amount of error. Taking averages allows the model to pick up how well a year class increases over time. The average age in the catch from the CMP is based on past information and does not reflect the current situation. For example, if there is a reduction in the average age, is it due to an increase in recruitment or a reduction in older-aged fish?
- DFO Science is of the opinion that it is important to track the age composition in the survey and the fishery on a "real time basis" and that this should be incorporated into the decision rule process. If the MSE is working then we should see an improvement in the proportion of older fish in the fishery catch and in the survey abundance indices.
- D. Butterworth provided an explanation of the differences between the three new CMPs as illustrated in a one page document (*i.e.,* plot of average survey index (3-yr mean) *vs.* TAC). CMPR and CMPR- are more conservative models and illustrate the trade off between low TAC initially *vs.* later on in the future.
- Fig. 2a illustrates model trends in performance statistics when the fishery is immediately closed; observed trajectories are due to fluctuations in the resource, which can still drop below the B^{4-8}_{2000} reference level under no fishery (as indicated by the 2.5%ile). This can happen due to chance alone since recruitment is very restricted. We cannot do better than what we see in this plot based on the recruitment variability that is used.

- Fig. 2b illustrates the CMP with the "early pain" approach (CMPR-). The situation is not as good when a harvest is being taken, the catch comes down rather quickly and there is the possibility that the fishery would be closed (due to low R and survey B). The age 4-8 exploitable biomass does get down to the B_{2000} level, but not much below this. There is a need to have more stringent measures (i.e. TAC reductions in the order of 20-40%) if exploitable biomass goes down this low. If biomass goes outside the range illustrated by the upper and lower 2.5%iles, then we get into exceptional circumstances (EC). The rule for ECs is that something has to happen which takes the results outside the range of model predictions. In this situation, judgement is required (the model does not have to be abandoned).
- Fig. 3 illustrates trends in total catch and B^{4-8} / B^{4-8}_{2000} for C=0 and three CMPs based on results from the RS. The main point is that if a high TAC is desired initially, then catches may have to be lower later on. There was discussion on what sort of reference level the group would like to use for the biomass trajectories. One suggestion was to use the average for the time period rather than the low level from 2000. This is not a limit reference point but rather it is a way of looking at what has happened in the past. The shape of the curve is more important than where the horizontal line is. Ultimately, this decision could be made at the May meeting. It was suggested to add $B^{4-8} / B^{4-8}_{2000} = 2.0$
- Fig. 4 illustrates 10 simulations for 6 OMs. Any one of these lines could happen, and the main point from these plots is that there is considerable variability in terms of future catch and exploitable biomass.

3. NEXT STEPS

Discussion of acceptable levels of risk. Further discussion is required concerning the range of risk levels to which further possible CMP variants might be tuned. It was proposed there be an internal discussion first (Fisheries Management and Industry), noting that we are dealing with very variable resources that fluctuate greatly, and that the MSE approach deals with a wide range of possibilities rather than the best assessment.

Further refinements to the CMPR. There will also be two "new" CMPs, one using $B^{4-8} / B^{4-8}_{2000} = 0.9$ (lower than the current reference level of 1.0) and another CMP using a reference level of 2.0, the idea being that this will give a broader range of performances for contrast and will aid managers in making decisions on acceptable levels of risk.

Additional OMs. The current Reference Set is based on stock dynamics from past discussions (before the coding error was detected). While it could be useful to look at other more optimistic scenarios with better future recruitment and lower levels of M, it was concluded that the Reference Set would not change for the May RAP.

Two options were suggested for further OMs to address the possibility of higher future recruitment:

- *Option 1* - if SSB goes up, then take a higher level of recruitment once a threshold is crossed
- *Option 2* - use recruitment from 1984-1994 period

These two approaches will provide "partially optimistic" and "overly optimistic" scenarios for future recruitment.

Exceptional Circumstances Protocol. Exceptional Circumstances are provisions that would be invoked to override the TAC recommendation provided by a Management Procedure if there was compelling evidence that the procedure was not working as intended or if observations fall outside the ranges that was tested. There is a need to draft an Exceptional Circumstances

document prior to the RAP meeting and a WG has been formed to do this. [Note the WG meets by phone 29 April 2011]

4. REVIEW OF PLANS FOR THE 9-10 MAY RAP

Agenda. In the interests of time, people were advised inform Julie Porter if they have changes to the draft agenda for the RAP. It was emphasized that considerable work would have to be done in advance of the meeting, and that participants should be prepared for a long day on the Monday. [Note: the CSA office sent the agenda to participants on 26 April 2011]

Documents (SAR and Working Paper(s)). The draft Research Document(s) will be made available hopefully 1 week in advance of the meeting. A draft SAR will be circulated a few days prior to the meeting.

Since this is the first time that a MSE approach has been applied in the Maritimes, the group will need to clearly communicate what is being done and why we are doing it. In this case, the SAR will be longer than usual and the group will need to spend time writing it; specifically, input from Fisheries Management and D. Butterworth (in addition to Science) is required.

It was also noted that there needs to be some discussion on which figures to include in the SAR before the May RAP meeting (*i.e.*, shade plots *vs.* percentile plots).

5. CLOSE

The Chairs thanked the participants. There are no more full group conference calls scheduled before the May RAP, though there will be several smaller discussions (Exceptional Circumstances, SAR Drafting, Acceptable Levels of Risk). Participants will be sent the links when documents are posted.

6. REFERENCES

Porter, J.M., and Docherty, V., Chairpersons. 2011. Proceedings of 4X5 Pollock Management Strategy Evaluation Workshop – 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2945: iv + 158 p.

APPENDIX 4c1. DIFFERENCES BETWEEN CMPs

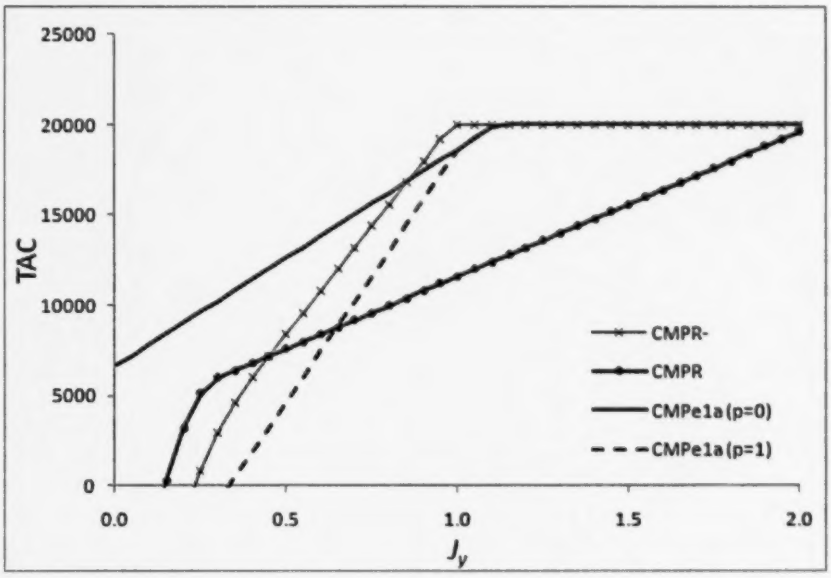
The primary difference amongst the various CMPs that have been proposed for the Pollock population lies in the formula that calculates the TAC from the survey abundance data (before any constraints on the maximum extent of change allowed come into play). The actual value input to the formula (the J_y) is the average value of the output from the survey index (over all ages sampled) for the last three years.

The plot below shows the differences amongst these formulae (equations B1 and B2) before and after the detection of the error in the projection code. Before, for CMPe1a, the formula commences as CMPe1a (p=0), but over the first ten years changed smoothly towards CMPe1a(p=1) as the penalty term was phased in. The reason for this "phasing" was not to impact TACs too heavily during the initial phases of resource recovery, but later to penalize more heavily if the abundance index dropped appreciably so as to ameliorate the consequences of abundance dropping too low.

For the revised CMPs, there are only two corresponding plots: CMPR- and CMPR, as the plot for CMPR+ is the same as that for CMPR (those last two CMPs differ only in the inputs used to compute the TAC for 2012). Compared to CMPR-, CMPR increases catches less rapidly as the survey abundance index increases, but allows catches to be taken down to a lower survey level. The two give rise to roughly similar overall risks because of the error associated with the survey as an index of abundance. The consequences of such errors if the TAC increases rapidly with the survey index are that the TAC needs to be brought lower at lower index values to compensate for the survey error corresponding to a larger proportion of the actual abundance.

Note that for the initial years CMPR- is more conservative than its earlier counterpart CMPe1a(p=0), but later changes to be less conservative. This is in an attempt to better safeguard industry catches, at least initially, if the survey index drops.

Further changes from the earlier to the new CMPs concern the restrictions on interannual TAC variation. Previously these were 20%, both up or down. The primary revision is that as the average survey index J_y drops below certain thresholds, larger extents of downward reduction (even fishery closure) become possible.



J_y Is a measure of the immediate past level in the survey abundance index relative to a target level as available to use for calculations for year *y*:

$$J_y = \frac{\sum_{y-2}^{y} I_y \Big/ 3}{\sum_{1984}^{1994} I_y \Big/ 11}$$ Where I_y is the survey abundance index in year *y*?